

Exploring the Strategy Choice of Education and Training Market Participants based on the Perspective of Evolutionary Game

Cairui Su¹ and Guoshun Ma^{2,*}

^{1&2}College of Mathematics and Statistics, Northwest Normal University Lanzhou 730070, China

ARTICLE INFO

Received: 11 September 2022

Revised: 05 October 2022

Accepted: 10 October 2022

Online: 16 November 2022

To cite this paper:

Cairui Su & Guoshun Ma (2022). Exploring the Strategy Choice of Education and Training Market Participants based on the Perspective of Evolutionary Game. *Journal of Quantitative Finance and Economics*. 4(2), 213-230. [https://DOI: 10.47509/JQFE.2022.v04i02.05](https://doi.org/10.47509/JQFE.2022.v04i02.05)

Abstract: The people's increasing attention to culture and education has caused vicious competition in the education and training industry, and false propaganda has disturbed the market order, and the education and training market is facing the choice of entry and exit. Based on the evolutionary game model, this paper explores the best strategic choice of the three parties involved in the education market by constructing an evolutionary game model of the strategic behavior choice of the regulator, education institutions and students, and using MATLAB simulation analysis to explore the direction of healthy, orderly and scientific development of the education market. The results show that the stronger the supervisory authority rewards (or punishes) the education and training institutions that adopt benign competition with credibility and credit evaluation, the more the education and training institutions tend to choose benign competition. The smaller the extra loss of training for students, the more inclined they are to choose to enroll. The higher the benefit of benign competition (or the cost of vicious competition) for teaching and training institutions, the more inclined they are to choose benign competition.

Keywords: Education and training industry; replicator dynamics; three-part evolutionary game; numerical simulation

1. Introduction

In today's knowledge-based economy, people's need for knowledge updating is becoming more and more urgent, prompting a significant increase in the amount of money and energy invested in education. In this context, off-campus training institutions have sprung up, and the rapid development of the education and training industry has also presented many problems. The lack of a sound regulatory mechanism for the education and training market by the relevant government regulators, the frequent occurrence of false advertising, chaotic fees, absconding of funds, poor teaching quality and weak teachers in training institutions have caused widespread concern in the society.

Regulating the education and training market is a daunting task. Caiyuan^[1] analyzed the current situation facing the education and training

market from the perspectives of the lack of a perfect education and training market regulatory mechanism in China, as well as the similarity of course contents, lack of personalization, single teaching mode and declining integrity of educational institutions, and proposed to set the threshold for training institutions to run schools and to strictly follow the access qualification to gatekeep. Yuan Zhi^[2] introduced the development of education and training market, established the evaluation system of non-academic education and training institutions in five aspects: business ability, financial status, management level, growth ability, and credibility and credit, and improved the supervision system of non-academic education and training institutions in terms of joint supervision, the same supervision, deposit payment, risk control, sound regulations, and legal management. Since the implementation of the “double reduction” policy, Mao-Cong Zhang and Yu-Zhen Li^[3] draw on and reflect on overseas governance practices and experiences, and combine them with the actual situation in China. The establishment of a detection system with early warning, regulation and guidance to adjust and regulate the relationship between government regulation and market autonomy. Wang Jing^[4] et al. proposed the need to adhere to the concept of digital teaching, rely on information technology to improve management effectiveness, innovative teaching methods to enhance the learning experience, strengthen the application of digital technology, realize the interconnection of learning data to build a digital education and training system, and promote the digital transformation of cadre education and training. When Qiwen^[5] used rule of law thinking and rule of law to explore the path of legal regulation of adult education and training, found that the development of the adult education and training market has a wide space, a wide variety of education and training, but the level of schooling varies, the fees are high, the lack of legal regulation, an important reason is the existence of regulatory blind spots and risks, the urgent need to establish a sound legal system, improve the legal regulatory system, and promote the healthy and orderly development of adult education and training work. Liu Shasha^[6] analyzed in depth the problems and reasons for the formation of the market order based on educational market theory and early childhood development theory, the obvious tendency of meritocracy on the supply side of the market and irrational consumption behavior on the demand side, and put forward corresponding countermeasure suggestions from various aspects.

In summary, the analysis finds that it is necessary to combine multiple objectives such as supervision and management of education and training, and evaluation system of education and training institutions. We construct a three-party evolutionary game model of the regulatory department,

education and training institutions and students, get the benefit matrix and replicator dynamic equations, use evolutionary game analysis methods, analyze the stability of the equilibrium point, and conduct simulation analysis to explore the characteristics of the decision-making behavior of the main participants in the driver training market. The evolutionary game paths and strategies among the supervisory departments to strengthen supervision, benign competition among teaching and training institutions and student registration are proposed to explore the operation mechanism for the healthy and orderly development of the teaching and training market. Through the joint governance of multiple parties, the standardized and orderly, healthy and sustainable development of the education and training industry is comprehensively promoted. In turn, the proposal of regulating the education and training market is of certain importance to promote the problems that arise in the education and training market.

2. Basic assumptions and model construction

2.1. Model Assumptions

In this paper, we construct a three-way evolutionary game model of regulators, educational institutions and students in the education and training market to explore the optimal evolutionary path to obtain the best combination of strategies. The following hypotheses are proposed for this purpose.

- (1) All three game subjects involved in the game process are finite rational, and the information of each party is incomplete.
- (2) Let two strategies be available to all three participating actors. The set of strategies for the regulator is {strengthening regulation, not strengthening regulation }. To promote the teaching and training market to present a new situation of mutual communication and coordination, orderly competition, healthy and harmonious development, i.e., the regulator chooses to strengthen. It may also choose not to strengthen regulation because of the vast territory of China and the difficulty of regulating many training institutions. The collection of strategies for teaching and accompanying institutions is {good competition, bad competition}. Teaching and training institutions are facing new situations and new demands, and will choose benign competition if they want to develop in a competitive environment for a long time. They may also choose vicious competition in order to compete for students. The set of strategies for students is {enroll, don't enroll }. Students choose to

enroll in order to get good grades; they may also choose not to enroll due to their personal reasons.

- (3) The probability of the regulator choosing to strengthen regulation is x ($0 \leq x \leq 1$) and the probability of choosing not to strengthen regulation is $1 - x$; the probability of the Education and Training Institutions choosing healthy competition is y ($0 \leq y \leq 1$) and the probability of choosing vicious competition is $1 - y$; the probability of the student choosing to enroll is z ($0 \leq z \leq 1$) and the probability of choosing not to enroll is $1 - z$.
- (4) In order to construct the benefit matrix of the game between the supervisory department, the education and training institution and the students. Suppose that the supervisory department in the education and training market adopts the strategy of strengthening supervision, which is conducive to promoting the development of the education and training market, improving the quality of training, safeguarding the rights of students, and improving the education industry, let its social benefit be Π_{11} . Improve the quality management mechanism of education and training and the implementation of information technology and intelligent application of supervision requires investment cost C_{11} ($C_{11} \geq 0$); assuming that the regulator chooses not to strengthen the supervision strategy, from the perspective of industry services, the social benefit is Π_{12} ($\Pi_{12} \geq 0$) and the cost is C_{12} ($C_{11} > C_{12} \geq 0$). Assume that the education and training institution chooses a benign competition strategy to gain revenue Π_{21} ($\Pi_{21} \geq 0$), for which the education and training institution needs to invest in training equipment, personnel management, service products and other costs C_{21} ($C_{21} \geq 0$). Assume that the education and training institution chooses a vicious competition strategy to gain basic revenue Π_{22} ($\Pi_{22} \geq 0$) and costs C_{22} ($C_{22} \geq 0$), where $C_{21} > C_{22}$ and have $\Pi_{22} - C_{22} > \Pi_{21} - C_{21}$ in the short term. It is assumed that students can gain benefit Π_{31} ($\Pi_{31} \geq 0$) by choosing to enroll, while they need to pay tuition, invest time and energy, etc., and their cost is C_{31} ($C_{31} \geq 0$). Students who choose not to enroll strategy will have neither benefit nor cost. In the case of stronger regulation by

the regulator, the benign competition education escort agency may receive policy incentives or good reputation rating as additional benefit $S (S \geq 0)$. The teaching and training institutions violate the law and vicious competition are punished by the regulatory authorities $p (P \geq 0)$, and $P \geq \Pi_{22} - C_{22}$, and may also bring losses due to the punishment A_1 . Assuming that vicious competition among educational institutions exposes students to risks including inconvenient transportation, poor facilities, and secondary charges, which brings losses $A_2 (A_1 > A_2)$. Because of competition among educational institutions, students can obtain quality services from other benign competition among educational institutions at this time, considering from the perspective of opportunity cost there is $A_2 > \Pi_{31} - C_{31}$. If students choose not to enroll, then the loss for the regulator is B_{31} , and the loss for educational institutions is B_{32} . If the teaching and training institutions compete viciously, and students enroll, it will reduce the credibility of the regulator to bring more losses $B_{21} (B_{21} > B_{31})$, and students enroll to increase social welfare $W_{31} (W_{31} \geq 0)$. According to the above assumptions, the benefit payment matrix of the three-party game is obtained as shown in Table 1.

Table 1: Benefit matrix of the game between regulators, driver training institutions and students

<i>Strategies</i>	<i>Regulatory authorities,</i>	<i>education and</i>	<i>students</i>
		<i>training institutions</i>	
(strengthen regulation, healthy competition, registration)	$\Pi_{11} - C_{11} + W_3$	$\Pi_{21} - C_{21} + R$	$\Pi_{31} - C_{31}$
(Strengthen regulation, healthy competition, no registration)	$\Pi_{11} - C_{11} + W_{31}$	$-C_{21} - V_{32} + R$	0
(Strengthen regulation, vicious competition, enrollment)	$\Pi_{11} - C_{11} + B_{21} + W_{31}$	$\Pi_{22} - C_{22} + P - L_1$	$\Pi_{31} - C_{31} - L_2$
(Strengthen regulation, vicious competition, no registration)	$\Pi_{11} - C_{11} + W_{31}$	$-C_{22} - B_{32} - P - L_1$	0
(No stronger regulation, healthy competition, enrollment)	$\Pi_{12} - C_{12} + W_{31}$	$\Pi_{21} - C_{21}$	$\Pi_{31} - C_{31}$
(No stronger regulation, healthy competition, no registration)	$\Pi_{12} - C_{12} + W_{31}$	$-C_{21} - B_{32}$	0
(No stronger regulation, healthy competition, no registration)	$\Pi_{12} - C_{12} + B_{21} + W_{31}$	$\Pi_{22} - C_{22}$	$\Pi_{31} - C_{31} - A_2$
(No stronger regulation, vicious competition, enrollment)	$\Pi_{12} - C_{12} + B_{31}$	$-C_{21} - B_{32}$	0

2.2. Replicate The Dynamic Equations

Based on the assumptions above, let the expected benefits as well as the average expected benefits of the regulator adopting the enhanced and non-enhanced regulatory strategies be U_{11}, U_{12} and \bar{U}_1 , respectively, then we have:

$$\begin{cases} U_{11} = yz(\Pi_{11} - C_{11} + W_{31}) + y(1-z)(\Pi_{11} - C_{11} - B_{31}) + (1-y)z(\Pi_{11} - C_{11} - B_{21} + W_{31}) \\ \quad + (1-y)(1-z)(\Pi_{11} - C_{11} - B_{31}) \\ U_{12} = yz(\Pi_{12} - C_{12} + W_{31}) + y(1-z)(\Pi_{12} - C_{12} - B_{31}) + (1-y)z(\Pi_{12} - C_{12} - B_{21} + W_{31}) \\ \quad + (1-y)(1-z)(\Pi_{12} - C_{12} - B_{31}) \\ \bar{U}_1 = x(U_{11}) + (1-x)U_{12} \end{cases} \quad (1)$$

The expected benefits and the average expected benefits of the education and training institutions choosing benign and vicious competition are U_{21}, U_{22} and \bar{U}_2 , respectively, then we have:

$$\begin{cases} U_{21} = xz(\Pi_{21} - C_{21} + S) + x(1-z)(-C_{21} - B_{32} + S) + (1-x)z(\Pi_{21} - C_{21}) \\ \quad + (1-x)(1-z)(-C_{21} - B_{32}) \\ U_{22} = xz(\Pi_{22} - C_{22} - P - A_1) + x(1-z)(-C_{22} - B_{32} - P - A_1) + (1-x)z(\Pi_{22} - C_{22}) \\ \quad + (1-x)(1-z)(-C_{22} - B_{32}) \\ \bar{U}_2 = y(U_{21}) + (1-y)U_{22} \end{cases} \quad (2)$$

The expected benefits and the average expected benefits for participants who choose to enroll and not to enroll are U_{31}, U_{32} and \bar{U}_3 , respectively, then we have:

$$\begin{cases} U_{31} = xy(U_{31} - C_{31}) + x(1-y)(\Pi_{31} - C_{31} - A_2) + (1-x)y(\Pi_{31} - C_{31}) \\ \quad + (1-x)(1-y)(\Pi_{31} - C_{31} - A_2) \\ U_{32} = 0 \\ \bar{U}_3 = z(U_{31}) + (1-z)U_{32} \end{cases} \quad (3)$$

Thus, the replication dynamic equation for the regulator is obtained as

$$F(x) = \frac{dx}{dt} = x(U_{11} - \bar{U}_1) = x(1-x)(U_{11} - U_{12}) = x(1-x)[\Pi_{11} - C_{11} - \Pi_{12} + C_{12}] \quad (4)$$

The replication dynamic equation for education and training institutions is

$$\begin{aligned} G(y) &= \frac{dy}{dt} = y(U_{21} - \bar{U}_2) = y(1-y)(\Pi_{21} - \Pi_{22}) \\ &= y(1-y)[C_{22} - C_{21} + x(S + P + A_1) + z(\Pi_{21} - \Pi_{22})] \end{aligned} \quad (5)$$

The replication dynamic equation for the students is.

$$H(z) = \frac{dz}{dt} = z(U_{31} - \bar{U}_3) = z(1-z)(U_{31} - U_{32}) = z(1-z)[\Pi_{31} - C_{31} - A_2 + yA_2] \quad (6)$$

3. Evolutionary equilibrium point analysis

Let $F(x) = 0$, $G(y) = 0$, $H(z) = 0$ and obtain 10 equilibrium points, respectively, $U_1(0,0,0)$, $U_2(1,0,0)$, $U_3(0,1,0)$, $U_4(0,0,1)$, $U_5(1,1,0)$, $U_6(1,0,1)$, $U_7(0,1,1)$, $U_8(1,1,1)$, $U_9(1, \frac{C_{31} + A_2 - \Pi_{31}}{A_2}, \frac{C_{22} - C_{21} + P + A_1}{\Pi_{22} - \Pi_{21}})$, $U_{10}(0, \frac{C_{31} + A_2 - \Pi_{31}}{A_2}, \frac{C_{22} - C_{21}}{\Pi_{22} - \Pi_{21}})$.

The Jacobian matrix of the three-party evolutionary game obtained from the replication dynamics equations (4), (5), and (6) is

$$\begin{aligned} J &= \begin{bmatrix} \frac{\partial F(x)}{\partial x} & \frac{\partial F(x)}{\partial y} & \frac{\partial F(x)}{\partial z} \\ \frac{\partial G(y)}{\partial x} & \frac{\partial G(y)}{\partial y} & \frac{\partial G(y)}{\partial z} \\ \frac{\partial H(z)}{\partial x} & \frac{\partial H(z)}{\partial y} & \frac{\partial H(z)}{\partial z} \end{bmatrix} \\ &= \begin{bmatrix} (1-x)(\Pi_{11} - C_{11} - \Pi_{12} + C_{12}) & 0 & 0 \\ y(1-y)(S + P + A_1) & (1-2y)[C_{22} - C_{21} + x(S + P + A_1) + z(\Pi_{21} - \Pi_{22})] & y(1-y)(\Pi_{21} - \Pi_{22}) \\ 0 & z(1-z)A_2 & (1-2z)[\Pi_{31} - C_{31} - A_2 + yA_2] \end{bmatrix} \end{aligned} \quad (7)$$

As the asymptotically stable solution of the replicated dynamic equations of the multi-group evolutionary game is a strict Nash equilibrium. The asymptotic stability of each equilibrium point is determined by using

Lyapunov's (Lyapunov's) first method by the positive and negative of the eigenvalues. The rules are as follows:

- (1) The equilibrium point is a stable point if all the eigenvalues have negative signs.
- (2) eigenvalues have positive signs, the equilibrium point is an unstable point.
- (3) If the eigenvalues are all zero or negative, the equilibrium point type is not determined.

The eigenvalues and symbols corresponding to the equilibrium are judged as shown in Table 2.

Table 2: Eigenvalues and sign judgments corresponding to equilibrium points

equilibrium point	Eigenvalue			Sign
$U_1(0,0,0)$	$\Pi_{11}-C_{11}-\Pi_{12}+C_{12}$	$C_{22}-C_{21}$	$\Pi_{31}-C_{31}-A_2$	(*,-,-)
$U_2(1,0,0)$	$-(\Pi_{11}-C_{11}-\Pi_{12}+C_{12})$	$C_{22}-C_{21}+S+P+A_1$	$\Pi_{31}-C_{31}-A_2$	(*,-,-)
$U_3(0,1,0)$	$\Pi_{11}-C_{11}-\Pi_{12}+C_{12}$	$-(C_{22}-C_{21})$	$\Pi_{31}-C_{31}$	(*,+,*)
$U_4(0,0,1)$	$\Pi_{11}-C_{11}-\Pi_{12}+C_{12}$	$C_{22}-C_{21}+\Pi_{21}-\Pi_{22}$	$-(\Pi_{31}-C_{31}-A_2)$	(*,-,+)
$U_5(1,1,0)$	$-(\Pi_{11}-C_{11}-\Pi_{12}+C_{12})$	$-(C_{22}-C_{21}+S+P+A_1)$	$\Pi_{31}-C_{31}$	(*,+,*)
$U_6(1,0,1)$	$-(\Pi_{11}-C_{11}-\Pi_{12}+C_{12})$	$C_{22}-C_{21}+S+P+A_1+\Pi_{21}-\Pi_{22}$	$-(\Pi_{31}-C_{31}-A_2)$	(*,+,+)
$U_7(0,1,1)$	$\Pi_{11}-C_{11}-\Pi_{12}+C_{12}$	$-(C_{22}-C_{21}+\Pi_{21}-\Pi_{22})$	$-(\Pi_{31}-C_{31})$	(*,+,*)
$U_8(1,1,1)$	$-(\Pi_{11}-C_{11}-\Pi_{12}+C_{12})$	$-(\Pi_{11}-C_{11}-\Pi_{12}+C_{12})$	$-(\Pi_{31}-C_{31})$	(*,+,*)

Note: * indicates symbol unknown

According to Table 2, the specific analysis is as follows.

(1) Under the assumptions, the cost C_{22} of bad competition is lower than the cost C_{21} of good competition. The net benefit $(\Pi_{22}-C_{22})$ of malignant competition in the education institution is higher than the net benefit $(\Pi_{21}-C_{21})$ of benign competition. The loss (A_2) to students caused by vicious competition among teaching and training institutions is greater than the net gain $(\Pi_{31}-C_{31})$ to students, i.e., $-(C_{22}-C_{21})>0$, $-(C_{22}-C_{21}+\Pi_{21}-\Pi_{22})>0$, $-(\Pi_{31}-C_{31}-A_2)>0$ holds constant. Therefore the equilibrium points $U_3(0,1,0)$, $U_4(0,0,1)$, $U_6(1,0,1)$, $U_7(0,1,1)$ are not asymptotically stable in any case.

(2) Under the assumption that the cost of vicious competition among education and training institutions is lower than the cost of benign competition among education and training institutions, and that the loss to

students caused by vicious competition among education and training institutions is greater than the net gain to students, i.e., $C_{22} - C_{21} < 0$, $\Pi_{31} - C_{31} - A_2 < 0$ holds constant. If the net benefit to the regulator of adopting stronger regulation is smaller than the net benefit of adopting no stronger regulation, i.e., $\Pi_{11} - C_{11} < \Pi_{12} - C_{12}$, then the equilibrium point $U_1(0,0,0)$ is the asymptotic stability point. Its corresponding strategy is (no enhanced regulation, vicious competition, no enrollment). This is the strategic behavior of the regulator belonging to the teaching and training institutions management is not standardized, teaching and training institutions due to interest issues, playing price war to attract students, resulting in the interests of students are damaged, students will choose not to enroll.

(3) Under the assumption that the loss to students from vicious competition among education and training institutions is greater than the net gain to students, i.e., $\Pi_{31} - C_{31} - A_2 < 0$ holds constant. If the net benefit of adopting stronger regulation by the regulator is greater than the net benefit of adopting no stronger regulation, i.e., $\Pi_{11} - C_{11} > \Pi_{12} - C_{12}$, and the sum of the additional benefit of the incentive gained by the education and training institution due to benign competition and the penalty P by the regulator under vicious competition and the loss A_1 due to the penalty is less than the cost difference between the cases of benign and vicious competition, i.e., $S + P + A_1 < C_{21} - C_{22}$. This is the way the relevant regulator will adopt to reduce the cost of stronger regulation to gain the net benefit of strong regulation. At this time, the regulatory authority is less strong in regulating the education and training institutions, and the training quality reputation reward strength received by the education and training institutions for benign competition and the punishment strength received for vicious competition violations are small, and the education and training institutions lack the awareness of benign competition and the training quality is not high. It can be obtained $U_2(1,0,0)$ is the point of gradual stabilization, corresponding to the strategic behavior (strengthening regulation, vicious competition, no registration). This corresponds to the period of education and training development, where the management mechanism has a preliminary system compared to the previous period, and some equipment has been introduced to improve the quality of teaching and training, but the organizational structure is not clear.

(4) According to the hypothesis, if the net benefit of taking stronger regulation by the regulator is greater than the net benefit of taking no stronger regulation, i.e., $U_{11} - C_{11} > U_{12} - C_{12}$, and the sum of the additional benefit S from the incentive gained by the education and training institution due to healthy competition and the penalty P by the regulator under vicious competition and the loss A_1 due to the penalty is greater than the cost difference between the cases of healthy and vicious competition, i.e., $S + P + A_1 > C_{21} - C_{22}$, the net benefit to students is negative, i.e., $\Pi_{31} - C_{31} < 0$. At this point $U_5(1,1,0)$ is the asymptotic stabilization point, and its corresponding strategy is (stronger regulation, healthy competition, and no enrollment). This is not in line with the operation mechanism of the education and training market.

(5) According to the hypothesis, if the net benefit of adopting enhanced regulation by the regulator is greater than the net benefit of adopting no enhanced regulation, i.e., $\Pi_{11} - C_{11} > \Pi_{12} - C_{12}$, the sum of the additional benefit S gained by the educational institution due to benign competition and the penalty p by the regulator under vicious competition and the loss A_1 due to the penalty is greater than the temptation of high net benefit from vicious competition, i.e., $S + P + A_1 > (\Pi_{22} - C_{22}) - (\Pi_{21} - C_{21})$, and the net benefit gained by students is positive, i.e., $\Pi_{31} - C_{31} > 0$. At this point, $U_8(1,1,1)$ is the asymptotic stability point, and its corresponding strategy is (stronger regulation, healthy competition, and enrollment). This is the best state for the regulator, the educational institution, and the student to achieve a win-win situation. The regulator strengthens regulation, the teaching and training institutions operate with integrity and improve teaching quality, and students choose training institutions rationally.

4. Simulation Analysis

Based on the analysis results, MATLAB software is used to simulate and analyze the dynamic evolution process. We find the corresponding strategic behavior that tends to the asymptotic stabilization point $U_8(1,1,1)$, i.e., the ideal state where the regulator strengthens the regulation, the educational institutions compete benignly and the students enroll. According to the initial conditions $\Pi_{11} - C_{11} > \Pi_{12} - C_{12}$, $S + P + A_1 > (\Pi_{22} - C_{22}) - (\Pi_{21} - C_{21})$,

$\Pi_{31} - C_{31} > 0$, let the parameters take the values of $\Pi_{11}=20, C_{11}=15, \Pi_{12}=12, C_{12}=10, U_{21}=20, C_{21}=17, \Pi_{22}=15, C_{22}=10, \Pi_{31}=5, C_{31}=4, S=3, P=2, A_1=2$ and $A_2=3$, respectively.

Let x_0, y_0 , and z_0 denote the initial proportion of students enrolled in the market due to the increased regulation by the regulator, benign competition among the education and training institutions, respectively. Due to the obvious increase in the importance of education, but the teaching and training market is full of chaos, the lack of market supervision and other factors. Based on this situation, set the initial state $(x_0, y_0, y_0) = (0.4, 0.2, 0.6)$, and obtain the simulation results as shown in Figure 1.

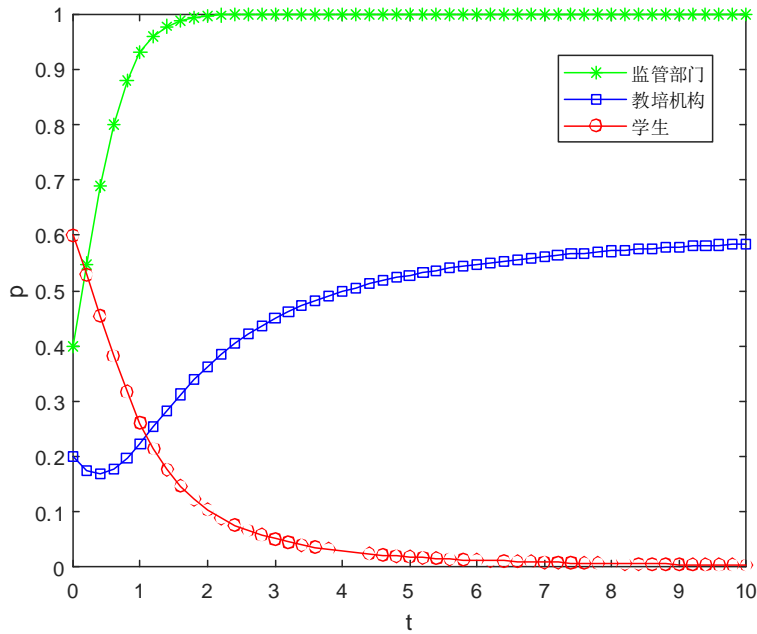


Figure 1: Simulation analysis of the point in the initial state

It is found that the optimal state may not be achieved when the initial conditions are met. For the regulator, the evolutionary path can be changed by considering two aspects: on the one hand, the regulator can increase the punishment P for teaching and training institutions with vicious competition, or increase the reputation reward S for teaching and training institutions with benign competition; on the other hand, the regulator can

reduce the loss of students by constructing a perfect regulatory system, and for teaching and training institutions, the two factors of revenue and cost can be Change the evolutionary path: on the one hand, through quality teaching concepts, improve reputation and attract more students to enroll, thus increasing the revenue of driver training institutions Π_{21} , on the other hand, reduce management costs through technical improvements or system optimization, i.e., reduce costs C_{21} .

Simulation analysis of the above four evolutionary pathways.

(1) In view of the increased efforts of regulators to crack down on non-compliant operations, the impact of penalty intensity P on the transactions in the education market is the same for vicious competing providers and benign competing providers receiving credibility rewards intensity S . Therefore, the impact of penalty intensity P is used as an example for analysis in this paper.

The first order partial derivative of Eq.(5)with respect to P gives Eq. (7).

$$\frac{\partial G(y)}{\partial P} = xy(1 - y) \quad (7)$$

In the three-dimensional space $V = \{(x, y, z) | 0 \leq x \leq 1, 0 \leq y \leq 1, 0 \leq z \leq 1\}$. Therefore, there is

$\frac{\partial G(y)}{\partial P} = xy(1 - y) > 0$. When the penalty intensity P of the regulator to the education and training institutions gradually increases, $G(y)$ also gradually increases. The effect of different values of penalty P on $G(y)$ is shown in Figure 2. When P is equal to 2, 5, 8, $G(y)$ tends to increase faster over time, indicating that the educational institutions tend to choose the strategy of benign competition more.

(2) From the position of the main body of student power. Sound industry system management system, good education and training institutions approval access, irregular inspection, timely handling of violations of the law, in order to reduce the students due to the vicious competition of education and training institutions to bring additional charges loss A_2 , that is, analysis of the impact of reducing additional losses on the behavioral strategies of students.

The partial derivative of Eq. (6) with respect to the loss A_2 is given by Eq. (8):

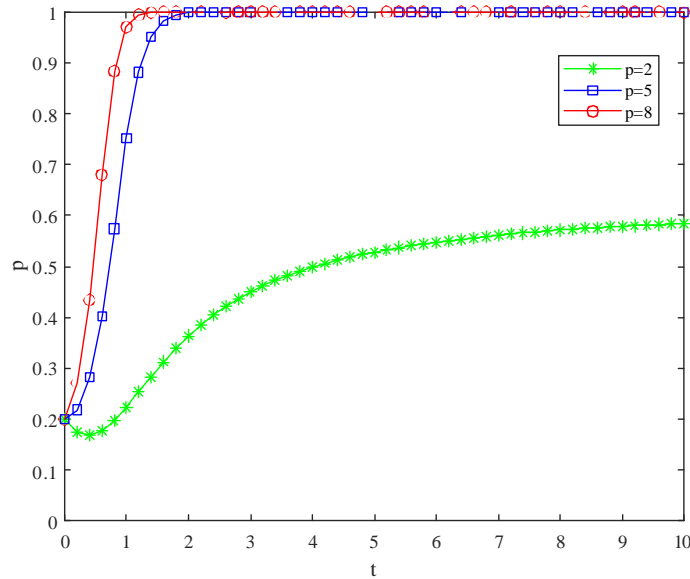


Figure 2: The impact of regulatory penalties on education and training institutions

$$\frac{\partial H(Z)}{\partial A_2} = -z(1-z)(1-y) \tag{8}$$

Similarly, we have $\frac{\partial H(Z)}{\partial A_2} = -z(1-z)(1-y) < 0$, i.e., the probability that a participant chooses to enroll gradually increases as the additional loss decreases. The effect of taking different values of the loss parameter A_2 on $H(z)$ is shown in Figure 3. When A_2 is equal to 3, 1.6, 0.8, $H(z)$ ends to be faster as time tends to 1, and students are more likely to choose to enroll.

(3) As a teaching and training institution, we should improve the quality and reputation of our training. By building a clear quality assurance system to ensure that the conditions of teachers To meet the demand, the teaching quality should be improved in order to enhance the core competitiveness of the market and seek new profit growth points. Therefore, we analyze the impact of improving the benign competition revenue Π_{21} of teaching and training institutions on the behavioral strategies of driving training institutions.

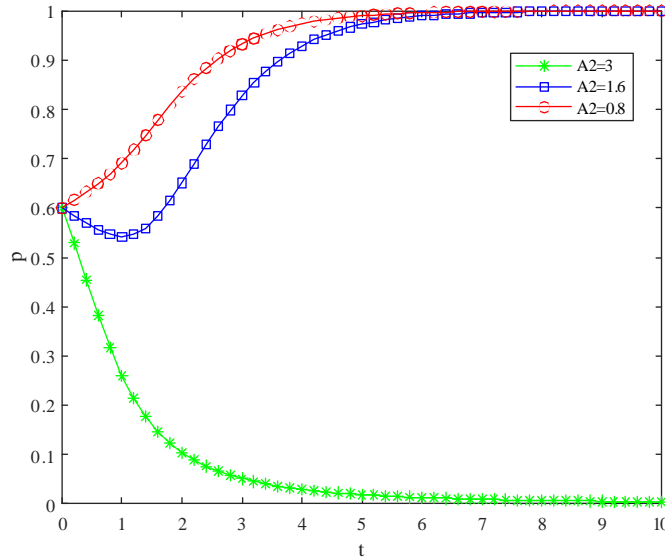


Figure 3: Impact of additional losses on students

The first order partial derivative of Eq. (5) with respect to Π_{21} gives Eq. (9).

$$\frac{\partial G(y)}{\partial \Pi_{21}} = zy(1-y) \quad (9)$$

Similarly, it is obtained that $\frac{\partial G(y)}{\partial \Pi_{21}} = zy(1-y) > 0$, i.e., as the benign competition gain Π_{21} increases gradually, $G(y)$ also increases gradually. The effect of taking different values of the parameter Π_{21} on $G(y)$ is shown in Figure 4. When Π_{21} gradually increases, i.e., Π_{21} equals to 20, 25, 30, $G(y)$ tends to 1 faster with time, the teaching and training institutions are more inclined to choose healthy competition, and the brand teaching and training institutions will be invincible.

(4) The new model of “Internet+” brings new possibilities to the education and training industry, providing traditional education with better opportunities to develop Internet education, further influencing the operation of education and training institutions in depth, improving enrollment, reducing operating costs and developing online education. At the same time, the illegal cost C_{22} of vicious competition is increased, making

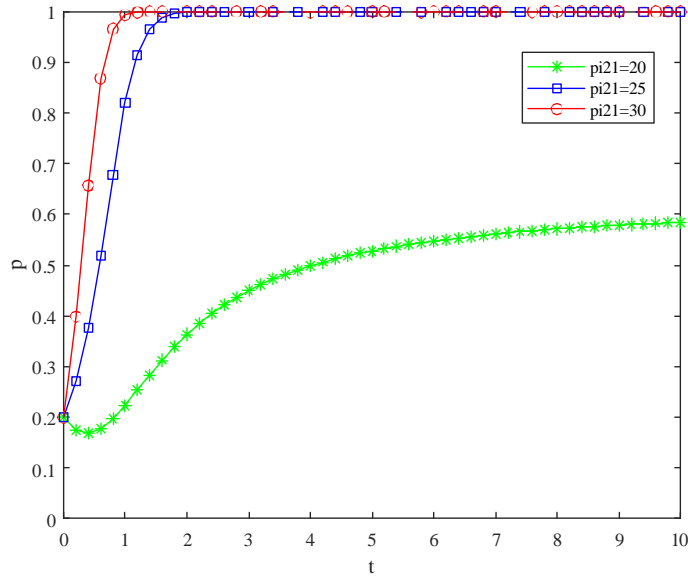


Figure 4: The impact of healthy competition gains on education and training institutions

it close to the cost of benign competition of education and training institutions. Therefore, to analyze the effect of increasing $C_{22} - C_{21}$ on the behavioral strategies of education and training institutions.

The first order partial derivative of Eq. (5) with respect to $C_{22} - C_{21}$ gives Eq. (10).

$$\frac{\partial G(y)}{\partial C_{21}} = y(1 - y) \tag{10}$$

Similarly, it is obtained that $\frac{\partial G(y)}{\partial C_{21}} = y(1 - y) > 0$, i.e., $C_{22} - C_{21}$

increases gradually as the cost difference $G(y)$ increases. The effect of taking different values of the parameter $C_{22} - C_{21}$ on $G(y)$ is shown in Figure 5.

When $C_{22} - C_{21}$ increases gradually, i.e., $C_{22} - C_{21}$ equals to $-7, -3, 5$, $G(y)$ tends to 1 faster with time, and the education and training institutions are more inclined to choose benign competition.

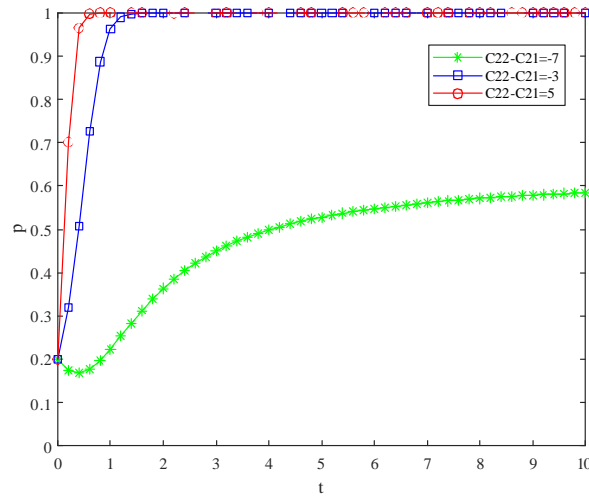


Figure 5: Impact of cost differential on education and training institutions

From the above analysis, we can see that the supervisory authorities should do a good job of supervision, increase the penalty for vicious competition, increase the credit reward for benign competition, and reduce the extra loss of students. By improving their own business philosophy, eliminating consumer fraud, enhancing their competitiveness, creating brand-name institutions, and using the “Internet + education” development model to reduce operating costs, the institutions can gradually become benign competition and students gradually tend to enroll, as shown in Figure 6.

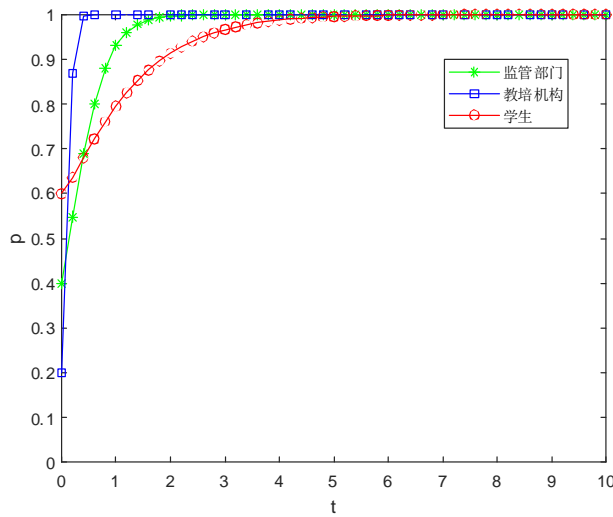


Figure 6: Simulation analysis of the point in the ideal state

5. Conclusion

Based on the evolutionary game theory, this paper constructs an evolutionary game model of the behavioral strategies of the regulators, education institutions and students, derives the three-party payment benefit matrix and replication dynamic equations, conducts asymptotic stability analysis of the equilibrium point, and conducts simulation analysis of the optimal state. It is found that in order to find a balance of interests for the healthy and sustainable development of the education and training market, multiple actors involved in the education and training market all have their own interests and responsibilities, different decision-making behaviors and different evolutionary paths. The ideal state for the development of the education and training market is to have stronger regulation by the regulator, healthy competition among education and training institutions and student enrollment. When the regulatory authority strengthens the regulatory strategy, the stronger the punishment for the vicious competition or the credibility credit reward for the benign competition, the more the educational institutions tend to choose the benign competition strategy. When education institutions build a perfect management mechanism, improve teaching quality, create brand institutions to increase long-term income, or reduce the operating cost of benign competition through "Internet +" and increase the cost of violating the law of benign competition, education institutions tend to choose benign competition strategy. In the vicious competition market, the less students lose, the more students tend to choose the enrollment strategy. In contrast, strengthening supervision by regulatory authorities, sound industry supervision and management, and improving law enforcement will help promote orderly competition among education and training institutions and improve the quality of education and training.

To create an orderly, healthy and harmonious education and training market. It requires the joint efforts of several education and training institutions management departments, such as the industry and commerce department, labor department and education department. Ensure that measures are steadily promoted to regulate the order of the education and training market, improve the quality of education and training, and promote the healthy, scientific and sustainable development of the education and training industry. To this end, the following recommendations are made.

Use laws, regulations and policy content to improve the student-oriented education and training market supervision mechanism, on the basis of a clear scope of government departments' inspection and supervision and power boundaries, build practical national standards, optimize the

industry's market access system, implement joint supervision, scientific supervision, and conduct regular and irregular inspections to nip various problems in the bud. Strictly control and punish education and training institutions that violate the law. As a profit maker, education and training institutions need to establish brand awareness, find their own positioning and advantages to create a high-quality brand, grow in scale and drive the development of the industry. Education and training institutions also need to improve their own business philosophy to eliminate consumer fraud. Finally, students should establish awareness of their rights, enhance their awareness of risk prevention, and enroll in formal training institutions through regular channels to avoid being deceived by false propaganda.

In conclusion, in order to promote the healthy, harmonious and orderly development of the education and training market, it is necessary for society, regulatory authorities, education and training institutions, students and other aspects to work together.

Acknowledgement

This research was financially supported by the National Nature Science Foundation of China(Grant NO.12061065 and Grant NO.12061066).

References

- Caiyuan. (2014). The current situation of China's education and training market and countermeasures [J]. *China Employee Education*, (12): 129.
- Yuan Zhi. (2011). A study on the market access of non-educational education and training institutions—Zhengzhou City as an example [C]. Henan University.
- Zhang Maocong; Li Yuzhen. (2022). The practical progression of China's education and training market governance [J]. *Shandong Social Science*, (09): 151-158.
- Wang Jing; Zhao Mingming; Wang Hongzhen. (2022). Exploring the problems of education and training of market supervision cadres in digital transformation - taking the General Administration of Market Supervision Network Academy as an example[J]. *China market supervision research*, (07):74-77.
- Shi Qiwen. (2015). Exploring the path of legal regulation of adult education and training[J]. *China Adult Education*, (13): 37-39.
- Liu Shasha. (2014). Survey and Diagnosis of Early Childhood Training Market - Taking Wenfeng District of Anyang City, Henan Province as an Example [C]. Henan University.